JOURNAL OF BIOMECHANICS

VOLUME 24 1991

LIST OF CONTENTS AND AUTHOR INDEX

PERGAMON PRESS
OXFORD · NEW YORK · SEOUL · TOKYO

Journal of Biomechanics

Affiliated with the American Society of Biomechanics, the European Society of Biomechanics and the International Society of Biomechanics

Editors-in-Chief

Rik Huiskes
Biomechanics Section, Institute of Orthopaedics, University of Nijmegen, P.O. Box 9101, 6500 HB Nijmegen, The Netherlands
Richard A. Brand
Orthopaedic Biomechanics Laboratory, 2430 Steindler Building, The University of Iowa, Iowa City, IA 52242, USA

Associate Editor

Paul D. Stein, *Division of Cardiovascular Research, Henry Ford Hospital, 2799 West Grand Boulevard, Detroit, MI 48202, USA*

Book Review Editor

Richard A. Brand (*see address above*)

Founding Editor

Verne L. Roberts, *Institute for Product Safety, Durham, NC, USA*

Editor Emeritus

F. Gaynor Evans, *Irvington, VA, USA*

Editorial Board

Thomas P. Andriacchi, *Rush-Presbyterian-St. Luke's Medical Center, IL, USA*
Aurelio Cappozzo, *Universita degli Studi 'La Sapienza', Roma, Italy*
Lance E. Lanyon, *University of London, UK*
Benno M. Nigg, *University of Calgary, Alberta, Canada*
John P. Paul, *University of Strathclyde, Glasgow, UK*
Malcolm H. Pope, *University of Vermont, VT, USA*
Albert B. Schultz, *University of Michigan, MI, USA*
Andrus Viidik, *University of Aarhus, Denmark*

Editorial Consultants

Gunnar B. J. Andersson, *USA*
James G. Andrews, *USA*
Theo Arts, *The Netherlands*
Antonio Ascenzi, *Italy*
Joseph C. Barbenel, *Scotland*
Juerg U. Baumann, *Switzerland*
Georg Bergmann, *FRG*
Necip Berme, *USA*
Thomas D. Brown, *USA*
David L. Butler, *USA*
Dennis R. Carter, *USA*
Donald B. Chaffin, *USA*
Krishnan B. Chandran, *USA*
Arthur E. Chapman, *Canada*
Marlyn E. Clark, *USA*
Stephen C. Cowin, *USA*
John D. Currey, *UK*
Jesús Dapena, *USA*
Dwight T. Davy, *USA*
Patrice Flaud, *France*
Cyril B. Frank, *Canada*
Edward S. Grood, *USA*
Herbert Hatze, *Austria*
Roger C. Haut, *USA*
A. L. Hof, *The Netherlands*
Robert S. Hutton, *USA*
Ivan Hvid, *Denmark*
Gerrit Jan van Ingen Schenau, *The Netherlands*
Hilaire C. A. Jacob, *Switzerland*
J. Lawrence Katz, *USA*
Albert I. King, *USA*
Paavo V. Komi, *Finland*
Doris Miller, *Canada*
Van C. Mow, *USA*
Klaus Nicol, *FRG*
Manohar Panjabi, *USA*
Solomon R. Pollack, *USA*
George T. Rab, *USA*
Guenter Rau, *FRG*
Erich Schneider, *FRG*
Bruce R. Simon, *USA*
Robert L. Spilker, *USA*
A. A. van Steenhoven, *The Netherlands*
Ian A. F. Stokes, *USA*
Peter A. Torzilli, *USA*
Peter S. Walker, *UK*
Nico Westerhof, *The Netherlands*
David A. Winter, *Canada*
Herman J. Woltring, *The Netherlands*
Savio L.-Y. Woo, *USA*
G. A. Wood, *Australia*
Ajit P. Yoganathan, *USA*
Ronald F. Zernicke, *USA*

Annual Subscription Rates 1992
Published monthly
Annual Institutional Subscription Rate (1992): £490 (US $785.00). Two-year Institutional Rate (1992/93): £931 (US $1491.50). Sterling prices are definitive. US dollar prices are quoted for convenience only, and are subject to exchange rate fluctuation. Prices include postage and insurance and are subject to change without notice. Subscription rates for Japan are available on request. Subscription enquiries from customers in North America should be sent to: Pergamon Press Inc., 395 Saw Mill River Road, Elmsford, NY 10523, USA, and for the remainder of the world to: Pergamon Press plc, Headington Hill Hall, Oxford OX3 0BW, UK. Telephone: Oxford (0865) 794141, FAX: Oxford (0865) 60285.

Back Issues
Back issues of all previously published volumes, in both hard copy and in microform, are available direct from Pergamon Press offices.

Publishing and Advertising Offices: PERGAMON PRESS
395 Saw Mill River Road, Elmsford, New York 10523, USA.
Headington Hill Hall, Oxford OX3 0BW, UK.
Telephone: Oxford (0865) 794141, FAX: Oxford (0865) 60285.

Copyright © 1991 Pergamon Press plc

It is a condition of publication that manuscripts submitted to this journal have not been published and will not be simultaneously submitted or published elsewhere. By submitting a manuscript, the authors agree that the copyright for their article is transferred to the publisher if and when the article is accepted for publication. However, assignment of copyright is not required from authors who work for organizations which do not permit such assignment. The copyright covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions, microform or any other reproductions of similar nature and translations. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the copyright holder.

US Copyright Law applicable to users in the USA

Photocopying information for users in the USA. The Item-fee Code for this publication indicates that authorization to photocopy items for internal or personal use is granted by the copyright holder for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service provided the stated fee for copying, beyond that permitted by Section 107 or 108 of the United States Copyright Law, is paid. The appropriate remittance of $3.00 per copy per article is paid directly to the Copyright Clearance Center Inc., 27 Congress Street, Salem, MA 01970.

Disclaimer. Whilst every effort is made by the publishers and editorial board to see that no inaccurate or misleading data, opinion or statement appear in this journal, they wish to make it clear that the data and opinions appearing in the articles and advertisements herein are the sole responsibility of the contributor or advertiser concerned. Accordingly, the publishers, the editorial board and editors and their respective employees, officers and agents accept no responsibility or liability whatsoever for the consequences of any such inaccurate or misleading data, opinion or statement.

Permission for other use. The copyright owner's consent does not extend to copying for general distribution, for promotion, for creating new works, or for resale. Specific written permission must be obtained from the publisher for such copying.

♾™The text paper used in this publication meets the minimum requirements of the American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials, ANSI Z39.48-1984.

The Item-Fee Code for this publication is: 0021-9290/91 $3.00 + .00

Contents

Volume 24 Number 1

M. G. Pandy and F. E. Zajac	1	**Optimal muscular coordination strategies for jumping**
K. T. Dodd and D. R. Gross	11	**Three-dimensional tissue deformation in subcutaneous tissues overlying bony prominences may help to explain external load transfer to the interstitium**
Shiping Ma and G. I. Zahalak	21	**A distribution-moment model of energetics in skeletal muscle**
T. W. Phillips, L. T. Nguyen and S. D. Munro	37	**Loosening of cementless femoral stems: a biomechanical analysis of immediate fixation with loading vertical, femur horizontal**
N. C. Jensen, L. P. Madsen and F. Linde	49	**Topographical distribution of trabecular bone strength in the human os calcanei**
N. Sasaki, T. Ikawa and A. Fukuda	57	**Orientation of mineral in bovine bone and the anisotropic mechanical properties of plexiform bone**
J. M. Czerniecki, A. Gitter and C. Munro	63	**Joint moment and muscle power output characteristics of below knee amputees during running: the influence of energy storing prosthetic feet**
P. O. Riley, M. L. Schenkman, R. W. Mann and W. A. Hodge	77	**Mechanics of a constrained chair-rise**
Technical Note		
T. P. Harrigan and W. H. Harris	87	**A finite element study of the effect of diametral interface gaps on the contact areas and pressures in uncemented cylindrical femoral total hip components**
Announcements	93	**Eighteenth International Congress of Theoretical and Applied Mechanics**
		Call for Proposals to Host IUTAM Symposia in 1994 or 1995

BM 24:12-I

Volume 24 Number 2

M. Shea, W. T. Edwards, A. A. White and W. C. Hayes	95	**Variations of stiffness and strength along the human cervical spine**
R. Baratta and M. Solomonow	109	**The effect of tendon viscoelastic stiffness on the dynamic performance of isometric muscle**
M. A. Adams and P. Dolan	117	**A technique for quantifying the bending moment acting on the lumbar spine *in vivo***
A. J. Beaudoin, W. M. Mihalko and W. R. Krause	127	**Finite element modelling of polymethylmethacrylate flow through cancellous bone**
J. J. de Koning, G. de Groot and G. J. van Ingen Schenau	137	**Coordination of leg muscles during speed skating**
R. F. Kuo, E. Y. S. Chao, K. Rim and J. B. Park	147	**The effect of defect size on the stress concentration and fracture characteristics for a tubular torsional model with a transverse hole**
Technical Notes		
J. M. Pereira, J. M. Mansour and B. R. Davis	157	**Dynamic measurement of the viscoelastic properties of skin**
S. H. Scott and D. A. Winter	163	**A comparison of three muscle pennation assumptions and their effect on isometric and isotonic force**
Book Review		
H. S. Borovetz	169	***Microvascular Mechanics—Hemodynamics of Systemic and Pulmonary Microcirculation***
Books Received	170	
Announcements	171	**First Symposium on Progress in Vertebral Column Research**
	171	**FIWAL: First Announcement of the ESB Workshop on Animal Locomotion**
	171	**Third International Conference on Physiological Fluid Dynamics**
	172	**Thirteenth Annual International Conference of the IEEE Engineering in Medicine and Biology Society**

	173	**First European Conference on Tissue Banking and Clinical Application**
	174	**International Scientific Conference on Prevention of Work-related Musculoskeletal Disorders**
Software Survey Section	I	

Volume 24 Number 3/4

K. Perktold, R. M. Nerem and R. O. Peter	175	**A numerical calculation of flow in a curved tube model of the left main coronary artery**
M. Gagnon and G. Smyth	191	**Muscular mechanical energy expenditure as a process for detecting potential risks in manual materials handling**
H. M. Toussaint, T. Janssen and M. Kluft	205	**Effect of propelling surface size on the mechanics and energetics of front crawl swimming**
P. Minotti and C. Lexcellent	213	**Geometric and kinematic modelling of a human costal slice**
K. M. Patil and J. K. Chakraborty	223	**Analysis of a new polycentric above-knee prosthesis with a pneumatic swing phase control**
Abstracts	235	**Fourteenth Annual Meeting of the American Society of Biomechanics**
Announcement	269	**European Intensive Course on Digital Imaging Processing Applied to Orthopaedic and Dental Implants**
Corrigendum	271	
Software Survey Section	I	

Volume 24 Number 5

G. J. Cooper, D. J. Townend, S. R. Cater and B. P. Pearce	273	**The role of stress waves in thoracic visceral injury from blast loading: modification of stress transmission by foams and high-density materials**
R. J. Gregor, P. V. Komi, R. C. Browning and M. Järvinen	287	**A comparison of the triceps surae and residual muscle moments at the ankle during cycling**

R. Ducharme, P. Kapadia and J. Dowden 299 **A mathematical model of the flow of blood cells in fine capillaries**

H. C. Han and Y. C. Fung 307 **Residual strains in porcine and canine trachea**

J. C. Lotz, T. N. Gerhart and W. C. Hayes 317 **Mechanical properties of metaphyseal bone in the proximal femur**

D. Mavrilas and Y. Missirlis 331 **An approach to the optimization of preparation of bioprosthetic heart valves**

Technical Note

P. G. T. van der Varst, P. L. M. Lemmens, M. C. R. B. Peters and A. J. M. Plasschaert 341 **Estimation of the mechanical lifetime of dental restorations: method and preliminary results**

Software Survey Section I

Volume 24 Number 6

Editorial

M. H. Pope 349 **The First World Congress of Biomechanics**

Papers

O. S. Mills and M. L. Hull 351 **Apparatus to obtain rotational flexibility of the human knee under moment loads *in vivo***

M. C. Hobatho, R. Darmana, P. Pastor, J. J. Barrau, S. Laroze and J. P. Morucci 371 **Development of a three-dimensional finite element model of a human tibia using experimental modal analysis**

K. B. Chandran, S.-H. Kim and G. Han 385 **Stress distribution on the cusps of a polyurethane trileaflet heart valve prosthesis in the closed position**

S. Dogan, P. A. Manley, R. Vanderby Jr, S. S. Kohles, L. M. Hartman and A. A. McBeath 397 **Canine intersegmental hip joint forces and moments before and after cemented total hip replacement**

K. Perktold, M. Resch and R. O. Peter 409 **Three-dimensional numerical analysis of pulsatile flow and wall shear stress in the carotid artery bifurcation**

T. Nambu, B. Gasser, E. Schneider, W. Bandi and S. M. Perren 421 **Deformation of the distal femur: a contribution towards the pathogenesis of osteochondrosis dissecans in the knee joint**

Technical Notes

M. Zagzoule, J. Khalid-Naciri and J. Mauss — 435 **Unsteady wall shear stress in a distensible tube**

J. E. Bechtold and D. R. Riley — 441 **Application of beams on elastic foundation and B-spline solution methodologies to parametric analysis of intramedullary implant systems**

Abstracts — 449 **Seventh Meeting of the European Society of Biomechanics**

Letters to the Editor

A. Pantokratoras — 493 **Comments on 'A new theoretical model for noninvasive quantification of mitral regurgitation' by E. G. Cape, A. P. Yoganathan and R. A. Levine**

E. G. Cape, R. A. Levine and A. P. Yoganathan — 494 **Authors' Response**

Book Reviews

G. Van B. Cochran — 495 ***Pressure Sores—Clinical Practice and Scientific Approach***

R. Kamm — 495 ***Respiratory Biomechanics—Engineering Analysis of Structure and Function***

Announcements — 497 **Biomed 91—First International Conference on Computers in Biomedicine**

498 **Fifteenth Annual Meeting of the American Society of Biomechanics**

Software Survey Section — I

Volume 24 Number 7

Zongping Luo and W. Goldsmith — 499 **Reaction of a human head/neck/torso system to shock**

T. P. Quinn, C. D. Mote Jr and H. B. Skinner — 511 **The effect of ankle constraint on the torsional laxity of the knee during internal–external rotation of the foot**

J. M. Huyghe, D. H. van Campen, T. Arts and R. M. Heethaar — 527 **A two-phase finite element model of the diastolic left ventricle**

A. D. McCulloch and J. H. Omens — 539 **Non-homogeneous analysis of three-dimensional transmural finite deformation in canine ventricular myocardium**

R. T. Schoephoerster and K. B. Chandran — 549 **Velocity and turbulence measurements past mitral valve prostheses in a model left ventricle**

C. J. Chuong, M. S. Sacks, R. L. Johnson Jr and R. Reynolds✠ — 563 **On the anisotropy of the canine diaphragmatic central tendon**

M. L. Hull, S. Kautz and A. Beard — 577 **An angular velocity profile in cycling derived from mechanical energy analysis**

Ming Yang and L. A. Taber — 587 **The possible role of poroelasticity in the apparent viscoelastic behavior of passive cardiac muscle**

W. K. Silk and M. Hubbard — 599 **Axial forces and normal distributed loads in twining stems of morning glory**

J. J. Crisco III, M. M. Panjabi and J. Dvorak — 607 **A model of the alar ligaments of the upper cervical spine in axial rotation**

H. E. J. Veeger, F. C. T. Van Der Helm, L. H. V. Van Der Woude, G. M. Pronk and R. H. Rozendal — 615 **Inertia and muscle contraction parameters for musculoskeletal modelling of the shoulder mechanism**

Technical Notes

D. R. Anderson, A. P. Newman and A. U. Daniels — 631 **The effect of test methodology on apparent compressive stiffness of tibiofemoral joint specimens**

S. C. Cowin, A. M. Sadegh and G. M. Luo — 637 **Correction formulae for the misalignment of axes in the measurement of the orthotropic elastic constants**

St. Holzreiter — 643 **Calculation of the instantaneous centre of rotation for a rigid body**

K. L. Andersen and L. A. Norton — 649 **A device for the application of known simulated orthodontic forces to human cells *in vitro***

Book Reviews

R. A. Brand — 655 ***Implantable Telemetry in Orthopaedics*, edited by G. Bergmann, F. Graichen and A. Rohlmann**

R. L. Lieber — 655 ***Muscles and Molecules—Uncovering the Principles of Biological Motion*, by G. H. Pollack**

R. A. Brand 656 ***Biomechanics of Diarthrodial Joints, Volumes I and II*, edited by V. C. Mow, A. Ratcliffe and S. L.-Y. Woo**

Software Survey Section I

Volume 24 Number 8

S. Hirokawa 659 **Three-dimensional mathematical model analysis of the patellofemoral joint**

O. S. Mills and M. L. Hull 673 **Rotational flexibility of the human knee due to varus/valgus and axial moments *in vivo***

A. Odgaard and F. Linde 691 **The underestimation of Young's modulus in compressive testing of cancellous bone specimens**

C. Högfors, B. Peterson, G. Sigholm and P. Herberts 699 **Biomechanical model of the human shoulder joint—II. The shoulder rhythm**

S. M. Belkoff and R. C. Haut 711 **A structural model used to evaluate the changing microstructure of maturing rat skin**

G. T. Wynarsky and A. B. Schultz 721 **Optimization of skeletal configuration: studies of scoliosis correction biomechanics**

T. H. Reif 733 **A numerical analysis of the backflow between the leaflets of a St Jude Medical cardiac valve prosthesis**

S. H. Scott and D. A. Winter 743 **Talocrural and talocalcaneal joint kinematics and kinetics during the stance phase of walking**

I. A. F. Stokes and M. Gardner-Morse 753 **Analysis of the interaction between vertebral lateral deviation and axial rotation in scoliosis**

G. A. Ateshian, L. J. Soslowsky and V. C. Mow 761 **Quantitation of articular surface topography and cartilage thickness in knee joints using stereophotogrammetry**

Letter to the Editor
T. Kardel 777 **A biomechanical revolution**

Announcements 779 **European COMETT Course on Biomaterial Monitoring of Orthopaedic Implants. A Biomaterials–Microelectronics Challenge**

779 **Ninth International Congress of ISEK**

Erratum 781

Software Survey Section I

Volume 24 Number 9

C. J. Snijders, G. A. Hoek van Dijke and E. R. Roosch 783 **A biomechanical model for the analysis of the cervical spine in static postures**

M. M. Black, I. C. Howard, X. Huang and E. A. Patterson 793 **A three-dimensional analysis of a bioprosthetic heart valve**

F. Linde, P. Nørgaard, I. Hvid, A. Odgaard and K. Søballe 803 **Mechanical properties of trabecular bone. Dependency on strain rate**

B. S. Myers, J. H. McElhaney and B. J. Doherty 811 **The viscoelastic responses of the human cervical spine in torsion: experimental limitations of quasi-linear theory, and a method for reducing these effects**

A. Quirinia and A. Viidik 819 **Freezing for postmortal storage influences the biomechanical properties of linear skin wounds**

S. J. Hollister, D. P. Fyhrie, K. J. Jepsen and S. A. Goldstein 825 **Application of homogenization theory to the study of trabecular bone mechanics**

J. M. Huyghe, D. H. van Campen, T. Arts and R. M. Heethaar 841 **The constitutive behaviour of passive heart muscle tissue: a quasi-linear viscoelastic formulation**

Technical Notes

T. R. Jensen, R. G. Radwin and J. G. Webster 851 **A conductive polymer sensor for measuring external finger forces**

S. C. Cowin and A. M. Sadegh 859 **Non-interacting modes for stress, strain and energy in anisotropic hard tissue**

Letters to the Editor

P. A. Altman and D. A. Hoeltzel 869 **Comments on 'The mechanical properties of the rabbit and human cornea'**

D. Maurice	871	**Author's response**
P. Altman and D. A. Hoeltzel	872	**Further comment on 'The mechanical properties of the rabbit and human cornea'**
D. Maurice	872	**Author's response**
J. P. Paul	873	**Comments on 'Estimation of instantaneous moment arms of lower-leg muscles'**
C. W. Spoor, J. L. van Leeuwen and A. Huson	873	**Author's response**
Announcement	875	**ESB Research Award**
Software Survey Section	I	

Volume 24 Number 10

M. A. Lafortune	877	**Three-dimensional acceleration of the tibia during walking and running**
J. P. Holden and P. R. Cavanagh	887	**The free moment of ground reaction in distance running and its changes with pronation**
D. V. Carmines, J. H. McElhaney and R. Stack	899	**A piece-wise non-linear elastic stress expression of human and pig coronary arteries tested *in vitro***
P. M. Pinsky and D. V. Datye	907	**A microstructurally-based finite element model of the incised human cornea**
R. Rieu and R. Pelissier	923	***In vitro* study of a physiological type flow in a bifurcated vascular prosthesis**
L. Hagberg, O. Wik and B. Gerdin	935	**Determination of biomechanical characteristics of restrictive adhesions and of functional impairment after flexor tendon surgery: a methodological study of rabbits**
J. A. Sidles, J. M. Clark and J. L. Garbini	943	**A geometric theory of the equilibrium mechanics of fibers in ligaments and tendons**
E. R. Serina and D. K. Lieu	951	**Thoracic injury potential of basic competition taekwondo kicks**

Technical Notes

M. L. Hitge, P. J. Torfs and D. D. Bicanic — 961 — **A novel approach to the distortion assessment of denture impression trays**

H. K. Ramakrishnan and M. P. Kadaba — 969 — **On the estimation of joint kinematics during gait**

Announcements — 979 — **Conference of the European Orthopaedic Research Society**

979 — **European Symposium on Clinical Gait Analysis**

Software Survey Section — I

Volume 24 Number 11

L. Yang, S. E. Solomonidis, W. D. Spence and J. P. Paul — 981 — **The influence of limb alignment on the gait of above-knee amputees**

R. Maroński — 999 — **Optimal distance from the implement to the axis of rotation in hammer and discus throws**

W. Zhu, W. M. Lai and V. C. Mow — 1007 — **The density and strength of proteoglycan–proteoglycan interaction sites in concentrated solutions**

L. Blankevoort, J. H. Kuiper, R. Huiskes and H. J. Grootenboer — 1019 — **Articular contact in a three-dimensional model of the knee**

R. O. Andres and D. B. Chaffin — 1033 — **Validation of a biodynamic model of pushing and pulling**

T. P. Harrigan and W. H. Harris — 1047 — **A three-dimensional non-linear finite element study of the effect of cement-prosthesis debonding in cemented femoral total hip components**

D. E. Swartz, R. H. Wittenberg, M. Shea, A. A. White III and W. C. Hayes — 1059 — **Physical and mechanical properties of calf lumbosacral trabecular bone**

P. R. Johnston and D. Kilpatrick — 1069 — **Mathematical modelling of flow through an irregular arterial stenosis**

Announcements — 1079 — **NATO Advanced Research Workshop: Advances in the Biomechanics of Hand and Wrist**

Software Survey Section — I

Volume 24 Number 12

J. Ø. Hjortdal, E. M. Pedersen, V. E. Hjortdal, J. M. Hasenkam, H. Nygaard, Yong Won Kim and P. K. Paulsen — 1081 **Velocity field studies at surgically imposed arterial stenoses on the abdominal aorta in pigs**

M. F. Bobbert, H. C. Schamhardt and B. M. Nigg — 1095 **Calculation of vertical ground reaction force estimates during running from positional data**

B. El. Nahass, M. M. Madson and P. S. Walker — 1107 **Motion of the knee after condylar resurfacing—an *in vivo* study**

P. DeVita, D. Hong and J. Hamill — 1119 **Effects of asymmetric load carrying on the biomechanics of walking**

D. R. Pedersen, T. D. Brown and R. A. Brand — 1131 **Interstitial bone stress distributions accompanying ingrowth of a screen-like prosthesis anchorage layer**

L. Røhl, E. Larsen, F. Linde, A. Odgaard and J. Jørgensen — 1143 **Tensile and compressive properties of cancellous bone**

F. C. T. Van der Helm and R. Veenbaas — 1151 **Modelling the mechanical effect of muscles with large attachment sites: application to the shoulder mechanism**

M. Fritz — 1165 **An improved biomechanical model for simulating the strain of the hand–arm system under vibration stress**

Z. Ladin and Ge Wu — 1173 **Combining position and acceleration measurements for joint force estimation**

Technical Note

J. C. Dean, C. H. Wilcox, A. U. Daniels, R. R. Goodwin, E. Van Wagoner and H. K. Dunn — 1189 **A new method for assessing relative dynamic motion of vertebral bodies during cyclic loading *in vitro***

Book Review

M. Kadaba — 1199 **Biomechanics of Human Movement: Applications in Rehabilitation, Sports and Ergonomics**

Announcements

1201 **International Symposium on Computer Methods in Biomechanics and Biomedical Engineering**

1201 **Symposium on Bi-articular Muscles**

1201 **Xth FINA World Sport Medicine Congress**

Software Survey Section I

Volume Contents and Author Index for Volume 24 i

Volume 24 Supplement 1

PROCEEDINGS OF THE NASA SYMPOSIUM ON THE INFLUENCE OF GRAVITY AND ACTIVITY ON MUSCLE AND BONE

Preface
R. T. Whalen v

Keynote Presentation
D. R. Carter, M. Wong and T. E. Orr 3 **Musculoskeletal ontogeny, phylogeny, and functional adaptation**

Musculoskeletal Forces
A. A. Biewener 19 **Musculoskeletal design in relation to body size**

W. Herzog and T. R. Leonard 31 **Validation of optimization models that estimate the forces exerted by synergistic muscles**

Structure
J. G. Tidball 43 **Force transmission across muscle cell membranes**

C. Gans and A. S. Gaunt 53 **Muscle architecture in relation to function**

M. Volpi and E. P. Katz 67 **On the adaptive structures of the collagen fibrils of bone and cartilage**

R. B. Martin 79 **Determinants of the mechanical properties of bones**

Adaptation
H. H. Vandenburgh, S. Hatfaludy, P. Karlisch and J. Shansky 91 **Mechanically induced alterations in cultured skeletal muscle growth**

E. H. Burger, J. Klein-Nulend and J. P. Veldhuijzen 101 **Modulation of osteogenesis in fetal bone rudiments by mechanical stress *in vitro***

R. H. Fitts, K. S. McDonald and J. M. Schluter 111 **The determinants of skeletal muscle force and power: their adaptability with changes in activity pattern**

V. R. Edgerton and R. R. Roy 123 **Regulation of skeletal muscle fiber size, shape and function**

S. A. Goldstein, L. S. Matthews, J. L. Kuhn and S. J. Hollister — 135 **Trabecular bone remodeling: an experimental model**

Metabolism

K. K. McCully, H. Kakihira, K. Vandenborne and J. Kent-Braun — 153 **Noninvasive measurements of activity-induced changes in muscle metabolism**

R. M. Dillaman, R. D. Roer and D. M. Gay — 163 **Fluid movement in bone: theoretical and empirical**